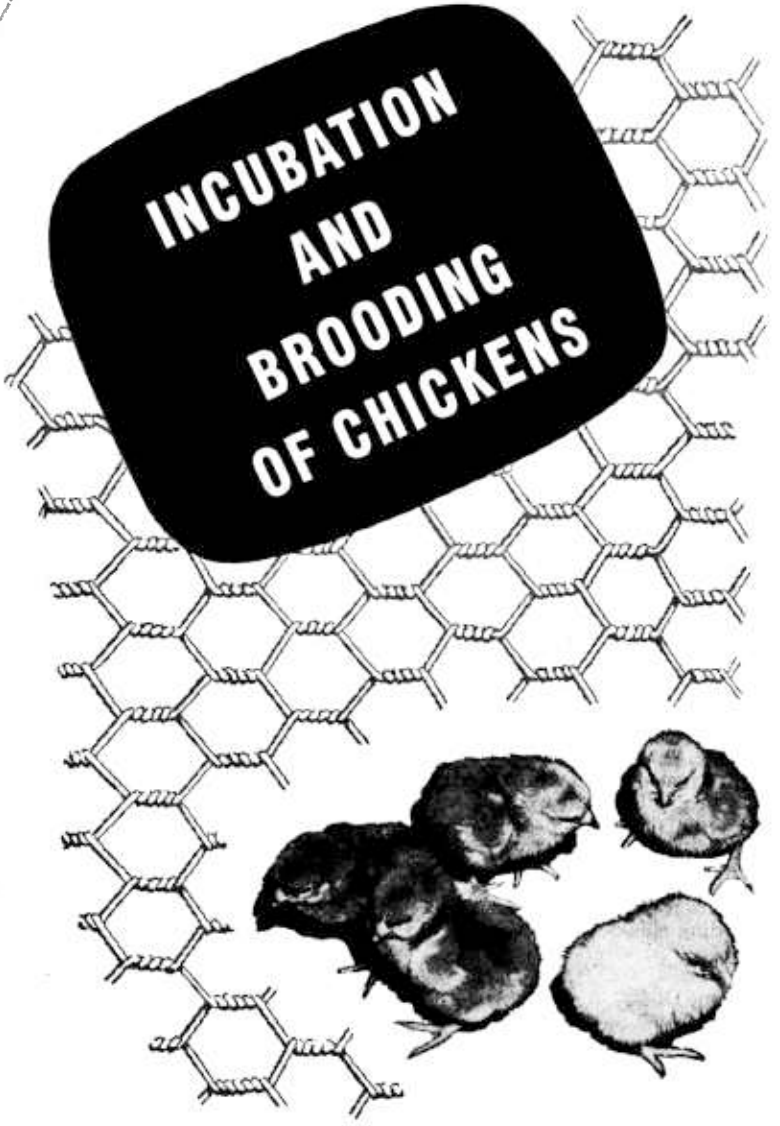
INCUBATION AND BROODING OF CHICKENS



FARMERS' BULLETIN NO. 1538

U. S. DEPARTMENT OF AGRICULTURE

THE REPRODUCTION of the flock from year to year is one of the poultry raiser's most important problems.

To insure success in incubation and brooding, hatching eggs must come from breeding stock of the highest possible quality and free from disease.

Growers find incubators and brooders economical and labor saving in reproducing the flock.

Proper temperature and ventilation and an adequate supply of moisture are essential to success in incubation.

Good brooding calls for temperature control according to the weather and the age of the chicks, plenty of room, not more than about 400 chicks in one flock, good ventilation, and clean houses and soil.

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INCUBATION AND BROODING OF CHICKENS

By M. W. OLSEN,[1] *poultry husbandman, Bureau of Animal Industry, Agricultural Research Administration*

REPLACING THE FLOCK

EFFICIENT METHODS of incubation and brooding are important to poultrymen. An average of about 275 million laying pullets a year are raised in the United States to replace that number of hens. About 450 million laying hens are kept on the farms of the United States. Of the hens and pullets on farms at the beginning of the year about 65 percent are culled or die. These are replaced by young pullets. Hens produce the most eggs during their first laying year. Production falls off about 20 percent the second year, and decreases gradually each succeeding year. At least once each year laying flocks should be culled closely to dispose of the poor producers. They can then be replaced by pullets to make a laying flock of more than 60 percent pullets. Many poultrymen make a clean sweep of all birds by the end of their first laying year, and keep only pullets for egg production.

The necessity of renewing more than 60 percent of the flock each year is one of the most important problems in poultry raising. Especially for beginners, this replacement process may be one of the principal causes of failure. Furthermore, methods of incubation and brooding affect to a considerable extent the profits to be made out of laying pullets. A poor hatch represents clear economic loss. The higher the death losses among chicks, the more certain that the breeding stock was inferior or diseased, or that methods of incubation or brooding were at fault.

INCUBATION

To obtain the largest possible number of good chicks in proportion to the number of eggs set, artificial methods of hatching chicks are generally used; it is estimated that more than 90 percent of all chicks produced are now coming from commercial hatcheries. On farms where 200 or more chicks are raised annually artificial methods of hatching and brooding have almost entirely replaced natural methods. Smaller farm flocks are also raised artificially although natural methods are still used on many farms. Where Leghorns or other nonsitting breeds are kept, artificial methods of incubation and brooding must be used.

Artificial incubation permits the hatching of chicks early in the spring so that the pullets will mature and begin laying in the early fall, when eggs are in demand. Hatching under hens does not usually produce early pullets. Where the chickens are hatched and

[1] Revision of former editions by M. A. Jull and A. R. Lee.

raised artificially, losses are smaller from lice and other parasites. Another advantage of the incubator is that chicks can be hatched in larger units. The use of incubators or the purchase of day-old chicks makes it possible to raise chickens in good-sized flocks under brooder stoves, greatly simplifying and reducing the labor.

TIME TO HATCH

Early hatching of chicks is important because the profits in poultry raising depend, to a considerable extent, on fall and early winter egg production. Egg sales bring in the larger part of poultry receipts both on farms and in commercial poultry plants. Farmers and commercial poultrymen need to realize that good egg production the year around is one of the most important things to work for.

The price of eggs is highest from about the first of September to the middle of December, and if egg production is good during that period egg profits are increased greatly. Unfortunately, on most farms and in many commercial poultry plants, it is during the fall and early winter months that the old hens are molting and pullets are not yet laying. Thousands of farmers could obtain greater returns from their flocks if their pullets were hatched early enough to begin laying in time for the high prices during the fall and early winter months. Pullets are almost the only source of eggs at that time of the year because hens are molting, which may take from 60 to 90 days.

Poultrymen can control production to a considerable extent by hatching pullets early enough to be in good laying condition by September or October. The earlier pullets are hatched the earlier they commence to lay. Moreover, early-maturing birds usually are the best layers. The pullets should be well-grown and of good size before they start to lay; otherwise the first eggs are likely to be small and the birds will not be well prepared for heavy egg production.

Pullets of any of the lighter breeds, such as Leghorns and Anconas, should come into laying when about 5 to 6 months old, and those of the heavier breeds, such as Plymouth Rocks, Rhode Island Reds, New Hampshires, and Wyandottes, should begin laying when from 5½ to 6½ months old. So, to take advantage of high egg prices during the fall and winter months, Leghorn pullets should be hatched about 6 months prior to October, and pullets of the heavier breeds about 7 months prior to the middle of October. In the South chicks hatched after the middle of April frequently do not do well. Therefore, most of the Leghorn chicks should be hatched before the first of April and most of the heavier breeds by the middle of March. In the North, most of the Leghorn pullets should be hatched before the middle of May, and the heavier breeds by the middle of April.

Farmers should hatch their chicks early to make the highest profits from eggs. Males may be sold as broilers early in the season, when prices are usually favorable. Still other advantages are that early fryers are ready for sale before the great bulk of the poultry goes to the market in the fall, and that roasters are well matured for the Thanksgiving market. Too many immature, scrawny chickens are sent to market. Early hatching will give a longer season for the chicken to mature and put on finish.

SANITATION IN INCUBATION

Lack of sanitation may cause poor hatches and high mortality in chicks. Hatching eggs should come from healthy breeding stock kept in sanitary quarters. The egg should be clean, because dirt on the shells may harbor disease organisms. Sitting hens should be treated with sodium fluoride to rid them of lice, and the nests should be kept clean and free from lice and mites. The incubators should be thoroughly cleaned and disinfected before eggs are placed in them. Be sure to remove all down and dirt from the incubator after each hatch, and to disinfect the interior of the machine as well as the egg trays and nursery drawers. Use cresylic disinfectant in a 3-percent solution. The larger, forced-draft incubators are usually disinfected by fumigation with formalin.

When using formalin, avoid breathing the fumes. Take care in using disinfectants as they are poisonous to man and livestock.

SELECTING HATCHING EGGS

Fertile eggs of good quality are necessary for good hatches. The kind of eggs incubated determines to a great extent, not only the quality of chicks which can be expected, but also the number. To insure fertility, it is advisable to mate the breeding stock about 8 to 10 days before starting to save eggs for hatching.

If you wish to check on the fertility of eggs before using them for incubation, break out a sample of new-laid eggs and examine the small germ spot. This spot, from which the embryo develops, is on one side of the yolk. If the egg is fertile, the germ spot will appear much like that in figure 1, *A*: circular, more or less translucent, and about three-sixteenths of an inch in diameter. If the egg is infertile, the germ spot will be much smaller and less regular in shape (fig. 1, *B*). Another distinguishing characteristic of an infertile egg is that the protoplasm in the germ spot of the yolk tends to accumulate in a dense white mass, which if carefully examined will be found to contain small cavities.

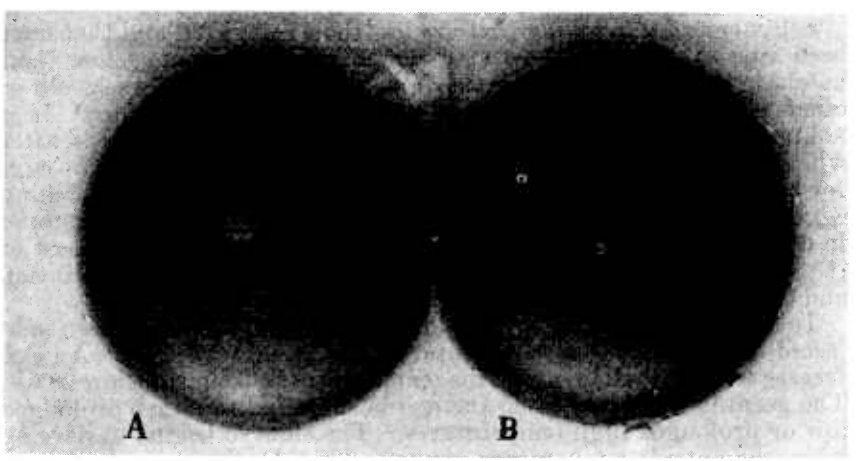

FIGURE 1.—*A*, The germ spot in this fertile egg is circular and about three-sixteenths of an inch in diameter. *B*, An infertile egg, the germ spot of which is much smaller and less regular in shape.

In general, select eggs for hatching that are of average size (23 to 26 ounces per dozen), normal in shape, of good shell texture, free from cracks and from such defects as blood spots and loose air cells. Excessively large as well as very small eggs are more likely to be infertile and to hatch fewer chicks than average-sized eggs. Table 1 compares the fertility and hatchability of eggs having eight types of undesirable characteristics with those of normal eggs. The 1,894 defective eggs were found among 47,950 new-laid White Leghorn eggs.

TABLE 1.—*Comparison of infertility and hatchability of various types of defective eggs with those of normal eggs*

Type of defective eggs	Number of eggs set	Percentage of total eggs examined	Number of infertile eggs	Percentage of eggs infertile	Number of chicks hatched	Percentage hatch	
						Fertile eggs set	Total eggs set
Cracked eggs	610	1. 27	155	25. 4	242	53. 2	39. 7
Extra large eggs (65 gr. or more)	332	. 69	113	34. 0	155	70. 8	46. 7
Small eggs (45 gr. or less)	155	. 32	80	51. 6	60	80. 0	38. 7
Misshapen eggs	68	. 14	21	30. 9	23	48. 9	33. 8
Poor shells	102	. 21	28	27. 5	35	47. 3	34. 3
Loose air cells	47	. 10	13	27. 7	11	32. 4	23. 4
Misplaced air cells	406	. 85	89	21. 9	216	68. 1	53. 2
Large blood spots	174	. 36	37	21. 3	98	71. 5	56. 3
All defective eggs	1, 894	3. 95	536	28. 3	840	61. 8	44. 4
Control eggs	3, 031	------	537	17. 7	2, 174	87. 2	71. 7

Some of these defects can be seen by careful inspection. Other types like blood spots, loose air cells, and fine cracks can be found only by candling the eggs.

Select eggs for hatching that are less than 7 days old and that have been stored in a cool place (50°–60° F.). Chicken eggs lose their hatching power rapidly after they are 7 days old; eggs 5 weeks old or older rarely hatch even if stored under favorable conditions. It is not necessary to turn eggs unless they are held more than 7 days, after which they should be turned daily. It is rarely advisable to save eggs for hatching longer than 2 weeks. The simplest way to hold hatching eggs is to keep them in wire baskets or egg cases (fig. 2). If stored in egg cases they should be packed with the blunt ends uppermost or if placed in trays (fig. 2) they may be kept in a horizontal position and turned by hand.

Take care that the eggs intended for hatching have not been subjected to prolonged low temperatures during cold weather. An egg freezes and the shell breaks if the temperature falls much below 28° F. The germ is weakened when the egg is subjected to either prolonged low or prolonged high temperatures. The embryo begins to develop when the outside temperature is above 80°. During hot weather as well as during cold weather it is important to gather eggs often and place them where a temperature of around 50° can be maintained.

FIGURE 2.—Room and equipment for holding hatching and market eggs at a temperature of about 50° F. The large cabinets at left and wire baskets allow for ventilation. Buckets and egg cases also may be used for holding eggs.

The adverse effect of temperature was shown in recent tests at Beltsville where five groups of eggs were subjected to temperatures of 30°, 40°, 50°, 60°, 70° F. for 2 to 8 days. The results of these tests given in table 2 show that only 2.2 percent of the fertile eggs hatched after being held at 30° F. for 6 to 8 days. The most favorable holding temperature was 50° F.

HATCHING WITH INCUBATORS

Artificial incubation is used to some extent all over the country by all kinds of poultry raisers. Practically all of the chicks for reproducing back-yard flocks and a large majority of those for commercial poultry flocks and general farm flocks come from commercial hatcheries. It is estimated that these hatcheries produce more than 90 percent of all chicks raised in this country.

Types of Incubators

Many makes of incubators are being used successfully in various parts of the United States. These incubators fall into two general groups, (1) the small, single-tier machines holding from 50 to 450 eggs, usually heated with kerosene lamps or with electricity, and (2) the mammoth incubators.

Most of the mammoth incubators are of the forced-draft type and practically all are now heated by electricity. These machines are in many sizes, holding from less than 1,000 to more than 75,000 eggs. Some of these large incubators are designed to incubate and hatch the

TABLE 2.—*The effect of holding eggs at different temperatures for periods of 2 to 4 days and 6 to 8 days prior to incubation*

Item	2- to 4-day holding period				
	30° F.	40° F.	50° F.	60° F.	70° F.
Eggs put in incubator	952	964	963	956	738
Percent of eggs fertile	87. 6	89. 2	89. 2	89. 2	91. 6
Percent of eggs with dead germs:					
1st week	30. 9	6. 4	7. 6	8. 0	7. 4
2d week	1. 2	1. 4	1. 1	1. 2	. 7
3d week	11. 2	11. 9	9. 9	11. 9	12. 1
Percent hatch of total eggs	50. 7	71. 7	72. 7	71. 2	73. 1
Percent hatch of fertile eggs	57. 9	80. 4	81. 5	79. 8	79. 7
	6- to 8-day holding period				
	30° F.	40° F.	50° F.	60° F.	70° F.
Eggs put in incubator	949	955	935	941	740
Percent of eggs fertile	90. 4	92. 9	90. 8	91. 3	93. 6
Percent of eggs with dead germs:					
1st week	97. 2	15. 4	10. 6	9. 0	10. 8
2d week	. 0	1. 1	1. 4	1. 5	1. 2
3d week	. 6	12. 3	9. 4	12. 8	14. 3
Percent hatch of total eggs	2. 0	66. 1	71. 3	70. 0	69. 1
Percent hatch of fertile eggs	2. 2	71. 1	78. 6	76. 7	73. 7

eggs in the same machine. Others are in two compartments, one for incubating and the other for hatching. The eggs are transferred from the incubator to the hatcher or hatching compartment on the 18th day. Consult the manufacturer's directions for specific instructions.

The small incubators are of two general types, hot air and hot water, the former being most commonly used. Both electric and kerosene lamps are used as the source of heat for many of the small incubators; electricity however is easier to regulate and has less fire risk than oil heat.

Two styles of incubator thermometers are used in the small single-tier machines. One is placed on the egg tray, with the bulb even with the top of the eggs, whereas the other is hung over the eggs so that the bulb just clears them. Because of the difference in temperature at various levels in these machines, it is very important that the thermometer be located so that the bulb is at the same level as the top of the eggs.

Accurate thermometers are essential for good results in incubation. In small still-air incubators, a temperature of approximately 102° F. throughout the incubation period is satisfactory. Thermometers may be tested by comparing them with a clinical thermometer in water heated to about 100° F.

Selecting an Incubator

Cheap incubators are usually less reliable, require more attention, and wear out much sooner than higher priced ones. As the value of the machine is small compared with the value of the eggs used during the normal life of an incubator, it is poor economy to purchase an unreliable machine.

The best size of incubator to buy depends on circumstances. It takes about as much time to care for a 60-egg machine as for one with a capacity of 360 eggs; it is generally advisable to get one of at least 150-egg capacity. Many poultry raisers like to have an incubator large enough to hatch most of their stock in 2 to 4 hatches. This saves time in tending the incubators and brooders; also the chickens will be more even in size. It may pay to buy an incubator large enough to do some custom hatching for others.

The hatching capacity required for the reproduction of the flock from year to year depends on the size of the flock as well as on the number of chickens required to be hatched at one time. To have a 200-bird flock, 50 of which are yearlings for breeding purposes and the remaining are pullets, at least 175 pullets should be raised to maturity to allow the culling out of 25 of the poorer ones. To have 175 pullets in the fall would mean that a flock of 350 chicks would have to be raised because practically half the flock will be males.

If you allow for about 15 percent mortality during the spring season, to have 350 chicks in the fall approximately 420 chicks would have to be hatched. If the chicks are hatched in 2 successive hatches, 420 chicks would require 210 chicks for each hatch, or about 350 eggs would have to be set each time, which would allow for a 60-percent hatch, giving 210 chicks. For 2 hatches, therefore, about 700 eggs would have to be set.

The Incubator Room

An incubator may be operated in almost any space within a building, but on a farm as good a place as any for a small incubator is a basement. A well-ventilated basement is usually much better than a room because the temperature is subject to less variation, the air usually contains more humidity, and there is less fire risk.

A special basement or incubator building is needed when large forced-draft machines are to be used. The main essentials of such a room are evenness of temperature, and good ventilation with sufficient moisture in the air. Most commercial hatcheries are in well-insulated buildings and are above ground. These large cabinet incubators are usually equipped with automatic devices by which humidity in the machines can be regulated.

The room should be large enough to allow the attendant to work around the machines conveniently. From 9 to 10 feet is considered a desirable height for the incubation room and about 70° F. the most desirable temperature. The shape and size of the room should be governed by the size of the incubators to be installed. Manufacturers of the various mammoth incubators furnish room plans with their machines.

It is advisable to install some system of ventilation in addition to the windows. This is to keep the room at a uniform temperature and the air fresh and free from offensive odors.

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Installing the Incubator

Small incubators should be installed according to the manufacturer's directions. A level should be used to see that the machines are perfectly level. Be sure that all parts of the incubator are in their proper positions and that the regulator works freely. If the door of the incubator sticks, do not plane off the edge until the machine has been heated and thoroughly dried. Incubators should be attended to at least three times daily. Incubators require careful and regular attention; neglect usually results in a poor hatch.

Regulating the Temperature

Manufacturer's directions for the operation of incubators should be followed closely until experience enables the operator to determine any minor variations that may be desirable. The following additional suggestions may be useful in operating incubators which are not forced-draft machines. Run the machine at about 102½° F. for at least 2 days before putting the eggs in. It takes several hours for the machine to come back to its correct temperature after the eggs are put in; therefore the regulator should not be touched during that time. Check the temperature of the incubator before opening the door of the machine to attend to the eggs.

The correct temperature depends on the type of machine and on the position of the thermometer in the egg chamber. A single-tier machine is operated at a temperature of about 102° F. In a good hatch the chicks in the eggs begin to pip on the evening of the 19th day. All of the chicks should be out of the shell by the morning of the 21st day. If the hatch is much earlier or much later it indicates that the temperature has not been correct.

The forced-draft type of incubator has uniform heat throughout and is operated at a lower temperature than the single-tier incubator. The large machines that are not equipped with hatching trays are operated at about 99½° to 100° F., and separate hatchers for these machines are sometimes run at about 97°. Incubators which do not have separate hatchers are usually operated at about 99½° to 99¾°.

Care of Small Incubator

In operating machines heated by oil, clean and fill the lamps once daily. Trim the wick by scraping the charred part off with a knife or by cutting the wick with scissors. Keep the burners free from dirt and clean them thoroughly after each hatch. A new wick for each hatch is a good investment, as it eliminates any danger of the wick becoming too short. Turn the eggs before caring for the lamp, so there will be no chance of getting oil on the eggs. Never fill a lamp while it is burning. The flame is apt to increase; always check the lamps after they are lighted. Small electric incubators are easier to regulate, require less labor, and are less likely to catch fire than lamp-heated machines.

Turning and Cooling the Eggs

Eggs are usually turned 3 to 5 times daily in lamp machines from the 2d until the 17th or 18th day, after which the chicks are due to pip. In large incubators various mechanical devices are used for turning the eggs, but most poultrymen using small machines prefer

to shuffle the eggs with their hands, removing a few from the center of the tray and working the others toward that point, placing on the sides of the tray those taken out. When time-saving mechanical devices are used, it is usually advisable to turn the eggs 3 to 5 times a day In two-tray lamp machines, after turning the eggs, reverse the egg trays end for end and from one side of the machine to the other.

Eggs do not need to be cooled during incubation unless they have been subjected to high temperature. Eggs are sometimes incubated at a subnormal temperature for several hours, because of interruption of electric current or other failure of heat. Eggs will hatch after being exposed to a temperature as low as 50° F. for several hours during the second week of incubation, but a longer period of incubation is generally required to complete the hatch in such cases.

Moisture Supply

A proper supply of moisture in the incubator is necessary for good results. The supply needed depends on the climatic conditions and on the room in which the incubator is kept. The amount of moisture needed can be estimated either by observing the relative increase in size of the air cell of the egg from time to time or by calculating the weight loss of the eggs. If suitable scales are available, the entire tray of eggs can be weighed and the weight recorded. The same tray of eggs can be weighed again after 7 days of incubation. The difference in weight represents the approximate amount of moisture which has evaporated during the 7 days. Divide this loss in weight by the original weight to obtain the percentage of moisture loss. The eggs should normally lose between 10 and 12 percent of moisture during the first 18 days of incubation. Too much moisture in the incubator prevents normal evaporation and results in a decreased hatch. Too little moisture, on the other hand, results in excessive evaporation, causing many of the chicks to stick to the shell. As the weather becomes warmer, more moisture is usually supplied. In still-air incubators moisture is supplied by placing large shallow pans of water below the egg tray or by sprinkling the eggs with warm water.

Humidity is automatically controlled in most of the forced-draft incubators by a humidifying device which keeps the moisture at the desired point regardless of the conditions outside. A relative humidity of about 57 percent should be maintained in the incubator. Humidity is about right when the wet-bulb reading is 86 in the incubator or 88 in the separate hatcher.

Figure 3 shows the comparative size of the air cells in an egg on the 7th, 14th, and 18th days of incubation in a forced-draft incubator. The air cell would be slightly larger in an incubator in which the moisture is not controlled automatically. The size of this air cell varies with the size and shape of the egg, and the shape of the air cell also varies in different eggs. If the air cell is too slow in enlarging it shows that too much moisture has been supplied. Too large an air cell indicates need for more moisture.

Testing Eggs

Operators of large hatcheries as a rule test eggs only once during the course of incubation. This is usually on the 18th day, when the eggs are transferred from the setting to the hatching trays. Candling

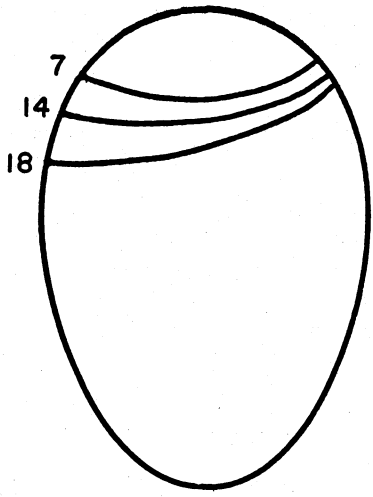

FIGURE 3.—Diagram showing the air cell on the 7th, 14th, and 18th days of incubation in forced-draft incubators.

under these conditions is usually done by simply moving the tray of eggs over a series of electric lights or by passing a bright spotlight under the tray. Infertile eggs and those in which the embryos have died appear clear before the light and are discarded.

Where only a small number of eggs are being incubated and labor cost is not a factor, the operator may desire to test the eggs more than once. A test in the early part of the incubation period has the advantage of indicating to the operator at that time approximately how many chicks he can expect.

At the Agricultural Research Center, Beltsville, Md., it has been the practice to test the eggs on the seventh day of incubation. The eggs are tested individually by placing the blunt end of each egg before the candler so that the condition of each embryo and the size of the air cell can be seen. At this stage in incubation, the embryo, if alive, appears dark with a surrounding network of blood vessels. The infertile egg, when viewed in the same manner, appears clear. If the embryo dies after 72 hours of incubation, the blood from the smaller vessels tends to gather in the larger ones, forming what is commonly known as a blood ring. All defective eggs should be removed at the time of candling.

White-shelled eggs can be tested as early as the 4th or 5th day of incubation with a commercial egg candler (fig. 4), but the embryos in brown-shelled eggs cannot be seen readily until the 6th or 7th day.

Recent research work at Beltsville has shown that with a little practice it is possible for a poultryman to detect fertility in both white and brown-shelled eggs as early as the 16th to 18th hour of incubation. After 24 hours it becomes increasingly difficult to detect fertility by this method. No special candling equipment is needed for this purpose except a good commercial egg candler equipped with a 60- to 75-watt daylight bulb. A blue-green light filter installed within the egg candler has been helpful, making the 18-hour embryo more visible. This same effect, however, can be obtained by wearing a pair of blue-green sun glasses while testing the eggs. For the beginner, it is

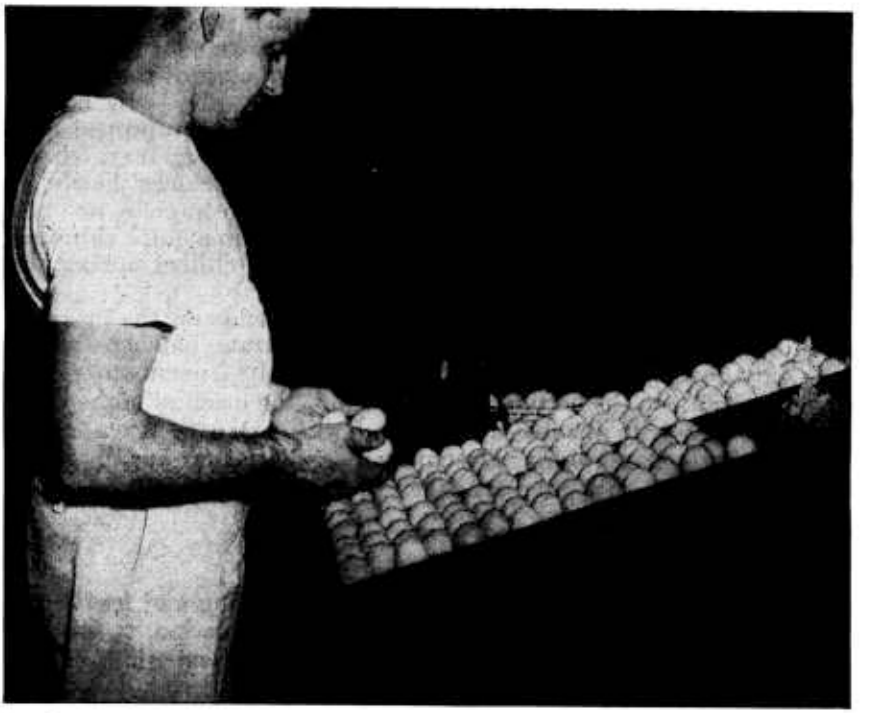

FIGURE 4.—Testing eggs for fertility and dead germs with a commercial egg candler.

advisable to candle white-shelled eggs first and after mastering the technique then candle the brown-shelled eggs.

The 18-hour embryo appears much like a bubble or spot about the size of a dime on the upper surface of the yolk. The infertile egg on the other hand appears clear, with no bubble-like spot.

On the 14th day the eggs containing strong, living embryos are dark and well-filled and show a clear, sharp, distinct line of demarcation between the air cell and the developing embryo, whereas eggs with dead germs show no blood vessels and only a partially developed embryo.

Removing the Hatch

Do not open the doors in the small single-tier incubators after the 18th day until the hatching is well over unless the machine is overcrowded. Opening the door allows moisture to escape and lowers the percentage of hatch. These machines are usually arranged with a movable piece of screen in the front of the egg tray, and this is removed when the hatch is completed, so that the chicks can get down into the nursery tray after they are dried off. In the forced-draft incubators, in which the humidity and the temperature are automatically controlled, it will not affect the hatch to open the doors after the 18th day provided they are closed promptly.

In small single-tier machines, remove the shells and eggs with dead embryos and place all the chicks in the nursery trays as soon as the chicks are through hatching, then set the incubator door slightly ajar to allow ventilation so that the chicks will dry off and harden

before being removed to the brooder. Chicks that pip but are unable to get out of the shell by their own efforts rarely amount to much if helped out. If it seems desirable, however, when most of the eggs are hatched and the chicks have dried off so that they will not be injured by opening the incubator door, any which have pipped may be helped out of the shell and placed back on the egg tray. Keep the temperature in the incubator, at a level of the chicks' heads, at about 95° F. for about 24 hours after the hatch is complete, or until the chicks are dry; then remove them to a brooder in a chick shipping box, being careful not to permit them to become chilled during the transfer.

The operation of forced-draft incubators depends on the make of machine. Most of these incubators have separate hatchers which have only nursery trays (fig. 5). Some forced-draft incubators have a hatchery unit in the bottom or in the top of the machine; others are equipped both with incubator trays and with hatchery trays, all of which are interchangeable. The chicks hatch in the nursery trays and are not disturbed until they are taken to the brooder or placed in the chick boxes for shipment.

Factors Influencing Hatches

Some of the causes of a poor hatch are the breeding and feeding of the breeding stock, faulty care of eggs before incubation, too-low or too-high temperatures, or too-low humidity during incubation. There

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FIGURE 5.—Chicks in a nursery tray in a forced-draft incubator.

are two critical periods during incubation, a low peak in mortality occurring on the 2d to 4th days and a very much higher peak about the 19th day.

Optimum conditions of incubation for forced-draft machines are: (1) a temperature of 99¾° to 100° F.; (2) a relative humidity of approximately 57 percent; (3) carbon dioxide content of not over 0.5 percent of the air in the incubator with the oxygen content approximately 21 percent. The eggs should be turned 5 or 6 times a day.

INCREASING DEMAND FOR DAY-OLD CHICKS

More and more farmers are buying day-old chicks instead of incubating eggs. The demand for chicks has resulted in a rapid growth in the hatchery industry, and it is estimated that more than 90 percent of all the chickens raised in farm flocks come from commercial hatcheries. Most young chickens are sold as day-old chicks just as soon as they are taken from the incubators. A small percentage of chicks are sold as "started" chickens when they are a few weeks old. In many hatcheries some of the chicks are separated at hatching time according to sex, the pullet chicks being raised for egg production and the cockerel chicks for meat production. These are referred to as "sexed" chicks, in which the Leghorn pullet chicks bring about twice the price of straight-run chicks. This difference in price is not so much in sexed chicks of the heavier breeds, as there is a good demand for cockerel chicks for broilers.

Farmers who buy chicks from commercial hatcheries should pay particular attention to the breeding and pullorum-disease-control program back of the chicks. A large number of breeders and hatcheries throughout the country are participating in the National Poultry Improvement Plan, which has as its primary purpose the improvement of chicks with respect to production and freedom from pullorum disease.

This malady, if uncontrolled, causes high mortality, as it is transmitted through the egg to the chick. The Plan is administered cooperatively by an official State agency in each of the cooperating States and the Bureau of Animal Industry of the United States Department of Agriculture. Following proper certification of the quality of their flocks and hatchery products by the State agency, participating flock owners, hatcherymen, or poultry breeders may then use the emblem, designs, and terminology of the National Poultry Improvement Plan.

The four progressive breeding stages of the Plan are U. S. Approved, U. S. Certified, U. S. Record of Performance, and U. S. Register of Merit. The three pullorum classes are U. S. Pullorum-Controlled, U. S. Pullorum-Passed, and U. S. Pullorum-Clean.

A list of breeders and hatcheries participating in the Plan may be obtained from any county agent or extension poultryman. To obtain a list of cooperators in all States, address a request to the Animal Husbandry Division, Bureau of Animal Industry, Beltsville, Md.

BROODING

The conditions of brooding should be such as to promote the most economical growth. Proper temperature, plenty of room, a constant flow of fresh air, and sanitation are most important. All chickens on commercial farms and most farm flocks are raised by artificial

methods. The use of brooders for farm flocks provides for brooding chicks in good-sized flocks, thereby reducing labor, and permits raising chicks early in the season.

SANITATION IN BROODING

One of the most frequent causes of failure in brooding chicks is lack of proper sanitation. Brood coops, brooders, and brooder houses are frequently allowed to get very dirty, and sometimes are never disinfected, with the result that the chicks become infected with coccidiosis, worms, or diseases. Thorough disinfection of brooding equipment and premises will do much to prevent the transmission of disease from infected to noninfected chicks. All equipment should be cleaned and disinfected with cresylic disinfectant before the brooding season begins and after each lot of chicks is brooded. Another effective disinfectant may be made by dissolving 1 pound of commercial lye and 2½ pounds of water-slaked lime in 5½ gallons of water.

Frequent cleaning of the brooder helps to keep chicks healthy. The soiled litter may be cleaned out and renewed after the first 10 days and every 5 to 7 days thereafter. However, commercial broiler raisers are getting good results with a deep litter in the brooder house, cleaning out the litter only when the chickens are marketed. Fresh litter is added frequently to the surface to keep it dry and clean. Clean litter is important because the floor soon becomes contaminated and disease is likely to spread from one chick to another.

A common cause of poor growth and high mortality in chicks is contaminated soil. Too frequently chicks are allowed to run with the adult birds on soil which is rarely cultivated or treated for parasites and disease organisms. In farm flocks, keep young chickens away from the laying flock. To remain free from intestinal worms and various diseases, chicks should be brooded on land over which the old stock has not been allowed to range for at least 1 year.

If the only yards available have been infected with disease germs, it may be advisable to keep young chickens on small outside wire floors or sunporches off the ground until 8 to 10 weeks old. A good grass range is most desirable; chicks should not be raised on bare land. The bare land immediately in front of the brooder house should be treated with lime, cultivated, and sowed to grass or some green crop.

Crowding chicks in the brooder may result in losses, as under such conditions it is difficult to keep the brooder pens sanitary and many chicks may become weak or runty.

BROODING CHICKS WITH HENS

Hens should be fed as soon as possible after the chicks are hatched, as feeding tends to keep them quiet; otherwise many hens will leave the nest. When several hens have been set to come off at the same time, it may be advisable to give the chicks hatching first to one hen and distribute the unhatched eggs among the other hens. In most cases it is best that the hens remain on the nest and brood the chickens for at least 24 hours after the hatching is over.

A hen will brood from 10 to 15 chickens successfully early in the season, and from 15 to 20 in warm weather, depending on her size.

In giving chickens to a hen which already has some to brood, it is best to do it at night and to add chicks of the same color and age as those already with her.

Chickens hatched during the winter, when the weather is cold, should be brooded in a poultry house or shed; after the weather becomes more favorable they may be reared in brood coops out of doors. Brood coops should be so made that they can be closed at night to keep out cats, rats, and other animals, but there should be ventilation enough to give the hen and chicks plenty of fresh air. The construction of brood coops should be such as to permit easy cleaning and spraying. An inexpensive coop is illustrated in figure 6. The floor dimensions of the brood coop should be about 20 by 30 inches and the height from 18 to 26 inches. Plans of brood coops may be obtained by writing to the poultry department of any State agricultural college.

The hen is usually confined in the coop or in a small yard attached to the coop until the chicks are weaned, the chicks being allowed free range after they are a few days old. The use of a small, covered yard attached to the coop gives the hen more freedom and keeps her in better condition than if she is confined to a coop all the time. Brood coops should be moved weekly to fresh ground, preferably where there is plenty of short grass.

3276-C

FIGURE 6.—Brood coop for hen with chicks. This coop, which has slats at the front, provides ample ventilation but does not protect the chicks from rats or other predatory animals.

Brooders with movable stoves or hovers are the most common. Other kinds are the battery brooders and the long continuous brooder house that may be heated by a hot-water-pipe system.

The individual stoves or hovers may use coal (fig. 7), oil, electricity, gas, or wood. They include all sizes from the 50-chick lamp brooder to stoves with a capacity of several hundred chicks. The coal stove is probably the most popular in sections of the country where coal is used generally and it is especially adapted for cold-weather brooding. Chestnut-size hard coal is usually used in the coal-burning stoves. Stoves adapted for burning soft coal are also available. Some of the other sources of heat are more readily adjusted for mild weather conditions, and all kinds are being used successfully. Oil-heated brooders are very commonly used on the Pacific coast and are popular in other regions.

Electric brooders are used where the electric current is dependable and the cost moderate. This type of brooder requires the least attention, is the easiest to maintain at the desired temperature, and offers less fire risk than most kinds of brooders. Lower electric rates and improved types of well-insulated electric brooders have materially reduced the cost of brooding chicks by electricity. Many operators use a piece of insulation board on the floor under the electric brooder or hover. Electric brooders are especially adapted for use in areas that have moderate temperatures.

Battery brooders, which are built from three to six decks high, are designed to keep a large number of chicks in a small space for a few

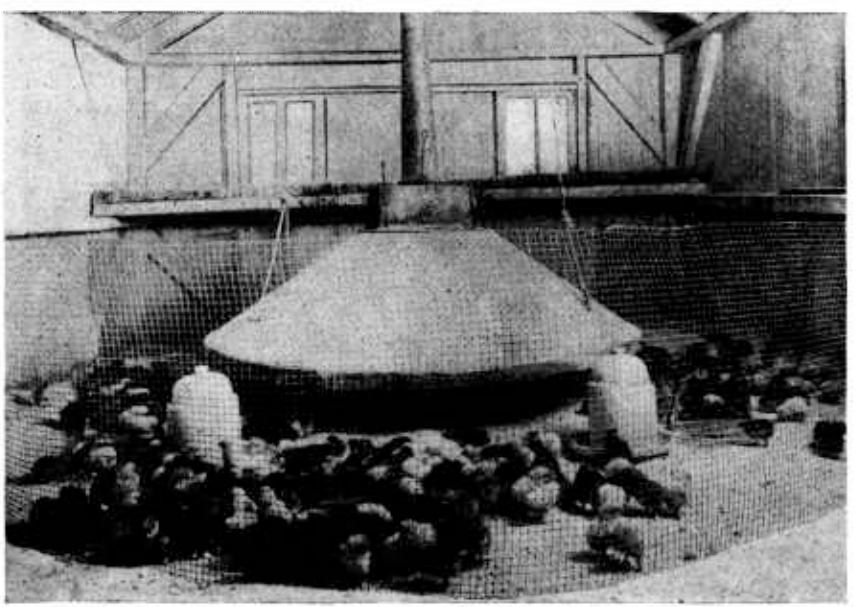

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FIGURE 7.—A cool-stove brooder with a brood of chicks. This type of brooder is well adopted for brooding chicks in flocks of from 150 to 400. Note particularly the wire fence, which prevents the chicks from going too far from the heat.

weeks. They are usually made of angle iron, galvanized steel, and heavy welded wire (fig. 8). Home-made batteries may be made with wooden frames, using heavy wire on the floors and front and lighter wire on the other sides. Most battery brooders are equipped with automatic heating devices in each unit but are usually operated in rooms in which supplemental heat is provided. Electric heating units, being easily controlled, are especially adapted for battery use but hot-water, oil-burning, and other types of batteries are all used with good results.

Continuous brooder houses, heated either with a central hot-water pipe system or with individual brooder stoves, are used on many large poultry farms and for commercial broiler production. Various types of individual brooder stoves, such as coal, oil, wood, and electric are used in these brooder houses without any supplemental heat. Supplemental heat is provided in some cases, especially where electric brooders are used. These long brooder houses are excellent for broiler produc-

10755-A

FIGURE 8.—Battery brooders with electric heating units in each compartment.

tion and may be used successfully with sun porches for brooding other kinds of chicks, but do not provide good outside yard or range conditions for raising pullets. A hot-water-pipe brooder house can be used to advantage only for brooding chicks and involves a heavy investment where chicks are brooded only during a few months of the year.

Recently, a new type of electric brooder heated with infrared bulbs has come into use. This brooder consists essentially of one or more infrared bulbs suspended from the ceiling, immediately above the chicks. The right brooding temperature is achieved by simply raising or lowering the infrared bulbs. Since no hover is used with this type of brooder, the chicks are always in full view. A guard of wire or corrugated board is used, as with other types of brooders, to confine very young chicks to a limited area near the source of heat.

Selecting a Brooder

The selection of the brooder is important because the successful brooding of chicks is frequently difficult. Cheap, unreliable brooders and thermostats may easily ruin many broods of good chicks. Be sure that the brooder is large enough, is made of good material, and that the thermostat is well constructed. The latter is a particularly important feature, because a poorly made thermostat may allow temperature changes that will be very harmful to the chickens. Most commercial brooders are overrated as to their chick capacity. A 52-inch hover will accommodate 300 chicks, providing approximately 7 inches of hover space for each chick.

There is considerable fire risk from brooders, another reason for selecting well-built machines.

For the farmer who raises from 400 to 600 chicks annually two brooder stoves would be satisfactory, one for the first hatch and another for the second. They are not expensive to operate and save much time in caring for the chicks. They are particularly serviceable to farmers who raise about 200 or more chicks annually.

Operation of Brooder

Chicks are usually left in the incubator from 18 to 24 hours after hatching, without feeding, before they are removed to the brooder. The brooder should have been in operation 3 or 4 days at the right temperature for receiving chicks. A beginner should try out his brooding system carefully before he uses it. Early mortality in chicks sometimes results from the chilling they receive while being taken from the incubator to the brooder and also as a result of not having the brooder running properly when the chicks are first put under the hover. In cool or cold weather the chicks should be moved in a chick box or other covered receptacle, and the temperature under the hover should be about 95° F.

The floor of the brooder house especially under and around the brooder stove should be covered with some fire resistant material. A 2-inch layer of fine sand makes a good litter and has the added advantage of being fire resistant. Materials like peat moss, wood shavings, sawdust, and ground corn cobs have also been used with satisfactory results after the chicks are a few days old. Care should be taken, of course, to keep combustible litter away from the brooder stoves especially at the time when ashes are to be removed.

Chicks should be fed just as soon as they are placed under the hover to keep them from eating the sand or other litter. Some poultrymen follow the practice of covering the litter with newspapers for the first few days while the chicks are learning to eat. This can be done with comparative safety if brooding is with electric brooders but it is not recommended with other types of brooders in which there is danger of fire.

At first when chicks are put under the brooder they should be confined around the hover by placing a guard of one-half inch mesh wire around the hover. The wire should be moved farther and farther from the hover and discarded entirely when the chicks are about 1 week old or when they are thoroughly trained in the use of the brooder (fig. 7). Pieces of wire mesh put across the corners of the house will prevent the chicks from crowding into the corners. This is important because many chicks may be smothered as a result of piling up in the corners. Baby chicks should be watched closely to see that they do not huddle or get chilled. If they begin the bad habit of toe picking, remove the wounded ones and paint their toes with tar. Getting the chicks outdoors will help to check this habit.

The chicks should always be kept comfortable. When too cold, they will crowd together and try to get nearer the heat. If in the morning the droppings are well scattered under the hover, it is an indication that the chicks have had heat enough. If the chicks are comfortable at night, they will spread to the edge of the hover, the position of the chicks varying somewhat with the different types of brooders and hovers. Too much heat causes them to pant and gasp and sit with their mouths open.

It is impracticable to state the temperature at which brooders of each style should be kept. Follow the recommendations of the manufacturer on this point. In most cases the brooder should be started at about 95° F., and the stove brooders are usually kept at that temperature for the first few weeks, because the chicks are able to adjust themselves to the heat, moving nearer or farther from the heat, according to the outside temperature. Small electric brooders and brooders with small hovers are usually started at about 95° and the temperature is reduced from 3½ to 5° weekly down to 70°. The best temperature to use depends on the season of the year, the number of the chickens and the style of the brooder. As the chickens grow larger and need less heat, it may be supplied at night only, and later on cold nights as needed. Take care to prevent chilling or overheating, which weakens the chickens, and may result in bowel trouble. The heat is usually cut off after the chickens are well feathered. Early in the season heat may be necessary for 8 to 12 weeks; later it may not be needed for more than 4 to 6 weeks.

Chicks need a cool place for exercising. The brooder stove is usually placed in the back part of colony brooder houses so that the front of the house will be cooler. Or the brooder house may be divided into two sections, one with the stove, and one a cool room for exercising and feeding. When the chickens are a few weeks old, low roosts should be placed in the rear of the brooder house. The chickens will soon learn to roost, and this will lessen overcrowding on the floor (fig. 9). Poultry raisers should bear in mind that chicks grow rapidly and frequently do not get ventilation enough if allowed to pile up on the floor.

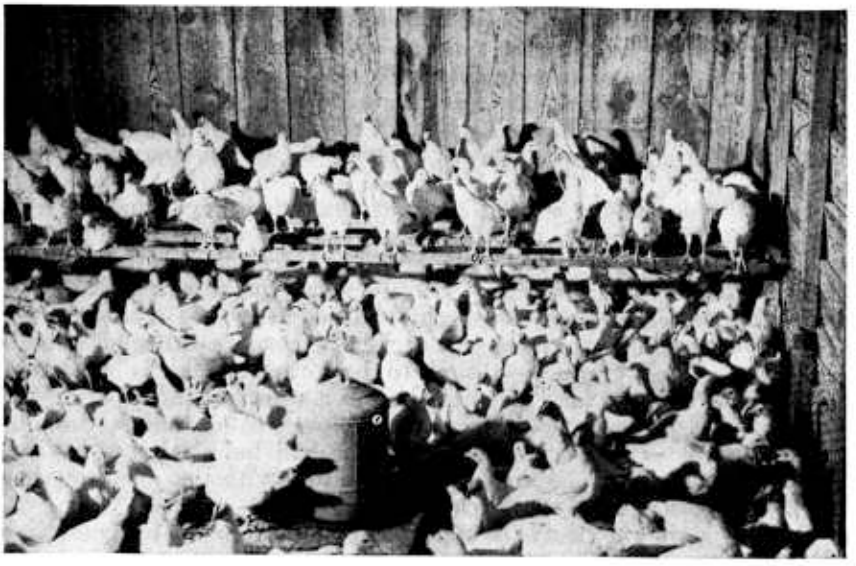

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FIGURE 9.—Interior of brooder house equipped with low roosts, which encourage chickens to begin roosting early.

The chicks should be allowed to run on the ground whenever the weather is favorable, provided the soil is not contaminated with worm eggs or disease germs. Be sure that the chicks can get in and out of the doorway readily; put a wire runway at the doorway. In many poultry plants that have had trouble with coccidiosis and intestinal worms, the chicks are confined to the brooder house or allowed only on small wire-floored sun porches or cinder or concrete yards for the first 4 to 10 weeks. Keeping the chicks off the ground during this period tends to control coccidiosis and worm infestation. Further information on controlling internal parasites is supplied in Farmers' Bulletin 1652, Diseases and Parasites of Poultry. When the chicks are first allowed to go outside they should be confined by a low wire fence which is taken away after about 2 weeks.

BROODER HOUSES

The houses in which chicks are brooded and reared should be well constructed and comfortable. A brooder house should be large enough so that the chicks are never crowded. It should be dry, easy to clean, well-ventilated, and free from drafts. Harmful gases may collect around the brooder in a poorly ventilated house.

The number of chickens to put in a brooder house or pen is affected by the length of time that the chickens are to be raised in these houses and by the outside yard or range space. About half a square foot of floor space should be provided per chick for the first 8 weeks. Where chickens are raised on range, from 200 to 350 chickens are put in colony brooder houses 10 by 12 or 10 by 14 feet in size. It is not usually desirable to brood more than 400 chickens in 1 flock in colony houses. A colony brooder house 12 by 16 feet will hold 400 chickens, but a house this size is hard to move.

The cockerels are usually removed when they are 6 to 8 weeks old. This makes space to raise the pullets in the colony brooder houses until they are ready to go into laying quarters. Smaller lots of chickens are brooded in smaller pens in long brooder houses equipped with outside sun porches, and the pullets are usually put in inexpensive range shelters when they are 6 to 10 weeks old, the time depending on the season of the year and on climatic conditions.

Brooder houses may be of stationary or portable types, as shown in figures 10 and 11. Portable, or colony, houses are built on heavy runners so they can be moved. Houses should not be located within 50 feet of other frame buildings. The colony brooder house (fig. 10) has openings on all sides for summer ventilation. The brooder-stove chimneys usually are placed at one end of the house. A ventilated thimble should be installed where the pipe passes through the wall. Houses with the pipe projecting through the roof require a special attachment around the pipe to keep water from running down and affecting the brooder stove and to protect the roof from fire. Colony brooder houses should be big enough to provide headroom for the attendant.

A long stationary brooder house with a wire-floored sun porch on the south side is shown in figure 11. The brooder houses illustrated in figures 10 and 11 are used with satisfactory results at the Agricultural Research Center, Beltsville, Md.

Plans for houses suited to conditions in any State may be obtained by writing to the poultry department of the State college of agriculture.

Chickens should be raised on new ground each year. This can be done readily by setting aside two fields in which to rear chickens and using one field for 1 year while the other field is in grass or growing a crop. Be sure, however, that the land used by the chickens has

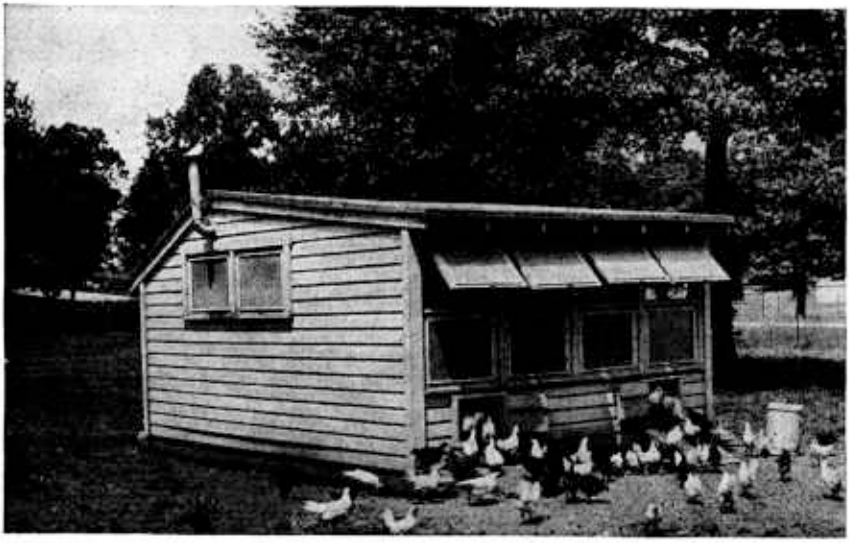

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FIGURE 10.—Hip-roof brooder house, 10 by 14 feet, on grass range with ample shade available. Note glass substitute windows which may be opened to provide ventilation.

good grass or is in clover, alfalfa, or some other tender green feed (fig. 10). Where there is a large orchard it may be divided into two parts, each part being used every other year.

There should be shade where chicks are reared, and if shade trees are wanting, a growing crop, such as corn, can provide shade. Also, the houses should be put where the chicks have ready access to plenty of green feed.

Many farmers and poultrymen would find it distinctly to their advantage to set aside two fields of the farm for the exclusive purpose of rearing chicks alternately with raising a crop. By following such a system about 750 chicks could be raised on 2 acres of good soil, divided into 2 fields of 1 acre each.

Above all, chicks should not be raised on the same land year after year, because soil contamination is one of the most important causes

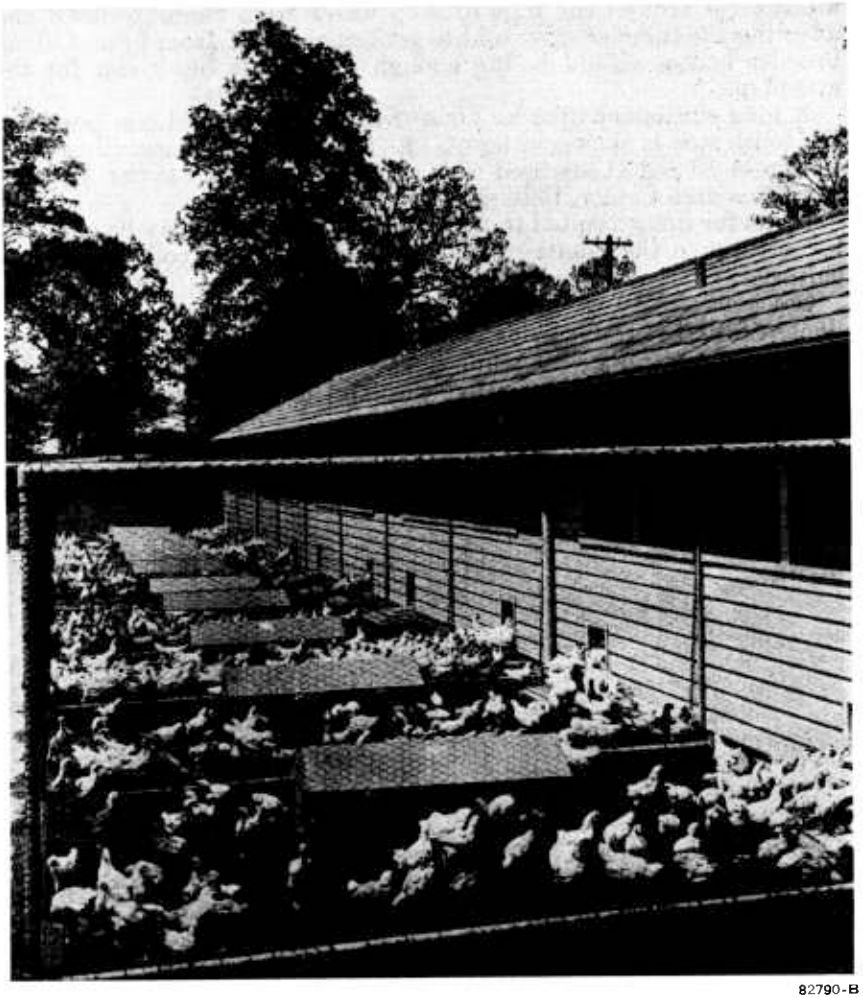

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FIGURE 11.—Long brooder house equipped with wire-floored sun porches and electric brooders.

of failure. On alternate years the ground should either be kept in grass or cultivated and sowed to a crop.

BROODING CHICKS IN CONFINEMENT

In many sections of the country, especially where commercial poultry raising is important, chicks are brooded in confinement. This method can be successful if suitable diets and good brooding methods are used. Leg weakness, which is likely to occur in chickens kept confined indoors, can be prevented by including suitable amounts of vitamin D and manganese in the ration. Confinement brooding may also be used to advantage to keep the chicks away from contaminated soil, especially where trouble has occurred from coccidiosis, roundworms, and tapeworms.

Confinement brooding is usually either brooding in long houses with or without outside sun porches, or battery brooding. Long brooder houses without sun porches are commonly used in commercial broiler production. Either long brooder houses or colony brooder houses with sun porches attached are used for brooding chicks in semiconfinement (fig. 11). Chickens are usually confined in these houses and yards through the brooding period and until they are 8 to 12 weeks old. Pullets to be raised for egg production or for breeding are then transferred to inexpensive range shelters.

BATTERY BROODING

Battery brooding is well adapted for starting chicks and for broiler production. Chicks may be started in battery brooders and kept there from 1 to 3 weeks before being transferred to other brooders. Batteries are sometimes used to carry chickens through the brooding period and are used widely for raising broilers up to 2 to 3 pounds in weight. Electrically heated batteries are usually operated in a room where a temperature of from 60° to 70° F. is maintained. The battery brooder is usually started at about 95° and the temperature is reduced to 75° by the time the chickens are 4 to 5 weeks old. At this age the chickens may be taken from the starting brooders and put in growing batteries.

Some commercial broiler raisers who maintain very uniform room temperatures start the brooders at somewhat lower temperatures than this and reduce the heat more rapidly. A fairly rapid reduction of temperature in the battery and a cool room temperature tend to stimulate good feather growth in broilers.

As the chickens are closely confined, feeding and management conditions must be kept just right for successful brooding in batteries. From 9 to 10 square inches of battery floor space should be allowed for each baby chick. To prevent crowding, this space per chick should be increased to about 18 square inches at 3 weeks, 30 inches at 6 weeks, and 50 inches at 10 weeks.

One great advantage in brooding chicks in confinement, particularly where large numbers are raised during the winter months, is the saving of labor. Either the individual-brooder or a continuous-brooder system is used in a long brooder house, which is divided into a number of pens, each large enough to accommodate from 200 to 500 chickens. Such an arrangement requires much less labor in caring for the chicks than does brooding under the colony brooding system, with the colony houses 100 to 125 feet apart.

PRECAUTIONS

Although brooding chicks in confinement saves labor, it also requires more careful management to avoid losses than does rearing chicks on range under the colony system, especially if new land is used each year. Not only do chicks brooded in confinement need more careful attention than chicks brooded on range, but there is greater danger of overcrowding, especially if the chickens are kept after they are 8 to 10 weeks old.

The space needed per chick depends on how long the birds are to be kept in the house. Up to 8 weeks, ½ square foot of floor space for each chicken should be provided; from 8 to 12 weeks, about 1 foot, and from 12 to 20 weeks 1½ feet. In some of the long brooder houses where broilers are raised under coal brooder stoves, 400 chickens are brooded in pens 10 by 20 feet and 400 to 500 birds are raised in a double pen, 20 by 20 feet, until they are marketed at 3 pounds weight.

Feather picking and cannibalism are frequent when chicks are brooded in confinement. Toe picking is usually the first trouble to make its appearance and may develop when the chicks are only a few days old. Tail picking may develop shortly after feathers have replaced the down, and body picking sometimes occurs as an aftermath of tail picking. Any one of the three troubles may occur even though good rations are being fed and when all conditions of brooder management are considered satisfactory.

These vices can usually be stopped by increasing the salt content of the diet for 2 or 3 days. If an all-mash diet is used, 2 percent of salt is added; but if both mash and grain are fed, 4 percent of salt is added to the mash. If the salt treatment does not stop the feather picking or cannibalism within 3 days, it may be advisable to trim back to the quick the upper mandible of the beak. Providing ruby-colored light in the pen, either with colored bulbs or painted windows, will help to prevent toe picking and feather picking. The simplest way to stop these vices is to let the chickens out of the brooder houses, if this is practical.

For the production of broilers, brooding in confinement has proved satisfactory, but where pullets are being raised for laying purposes it is advisable to give them range on clean soil.

PROBABLE CAUSES OF POOR RESULTS IN BROODING

Overcrowding is a very common cause of failure in brooding. Methods of brooding may have been at fault. The temperature may have been uneven, causing the chicks to become chilled, giving rise to such conditions as brooder pneumonia or bowel trouble. Poor-quality chicks are frequently a cause of poor results. The chicks may have come from weak or diseased stock. Adverse conditions of incubation may have affected the quality of the chicks. Lack of proper sanitation in the brooder house and contaminated soil are factors that frequently cause high mortality in chicks.

CARE OF CHICKENS AFTER BROODING SEASON

At 10 to 12 weeks of age chickens should be well feathered and should have learned to roost. Unless they are given sufficient house-room they are liable to get overheated on warm nights. Putting low

roosts in the brooder house, when the chickens are a few weeks old, helps to prevent crowding (fig. 9).

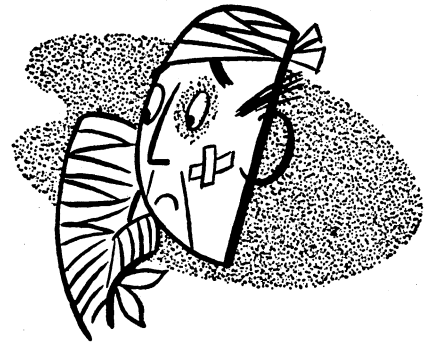
One good way of providing more room is to separate the sexes. This avoids the possibility of the cockerels annoying the pullets, and is especially desirable in order to allow the pullets to mature properly. Moreover, the cockerels may be sold as broilers or fryers early in the season or may be reared by themselves and sold as roasters in the fall.

During the summer months the houses should be well ventilated. This can be done by opening windows and ventilators on all sides. Range shelters provide excellent summer ventilation, as all sides of the building are open.

Chickens should be culled from time to time throughout the growing season. Remove weak chickens as they appear, because they rarely develop into profitable birds. Burn or bury diseased chickens at once, otherwise the healthy chicks may become contaminated. Keep houses and land in sanitary condition at all times, as it is the best insurance against ill health and also promotes growth. Shade is desirable for growing chickens, and can be provided artificially if no natural shade is available. The growth of chickens depends on the feeding and care the poultryman provides.

U. S. GOVERNMENT PRINTING OFFICE: 1953

Farm Accidents Each Year . . .

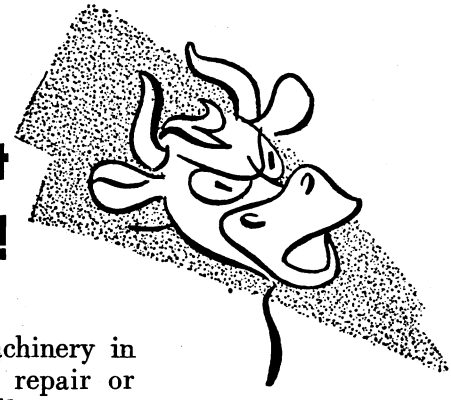


Kill about 15,000 people.

Injure or cripple about 1¼ million more.

Cause loss of 17 million man-days of farm labor, or the services of 46,000 men working every day for a year.

Help Prevent Most of These Accidents!



Keep tractors and other farm machinery in good repair. Equipment in bad repair or carelessly handled ranks first in killing or injuring farm people.

Handle bulls and other farm animals carefully. They rank second in causing farm accidents and deaths.

Use sharp-edged tools with caution—sickles, saws, corn knives, chisels, screwdrivers, axes.

Take proper care in using, handling, and storing insecticides and other poisonous chemicals.

Install, use, and repair electrical appliances and equipment properly.

You can lessen the seriousness of many accidents by immediate and proper care. Keep a first aid kit handy and know how to use it. **Call a doctor.**